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INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY
(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference 118039 JST	FOR FURTHER ACTION See Form PCT/IPEA/416	
International application No. PCT/SE2004/001032	International filing date (day/month/year) 24.06.2004	Priority date (day/month/year) 24.06.2003
International Patent Classification (IPC) or national classification and IPC G01J 1/42, B60H 1/00		
Applicant Accel AB et al		

- This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.
- This REPORT consists of a total of 6 sheets, including this cover sheet.
- This report is also accompanied by ANNEXES, comprising:
 - ☒ (sent to the applicant and to the International Bureau) a total of 5 sheets, as follows:
 - ☒ sheets of the description, claims and/or drawings which have been amended and are the basis of this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).
 - ☐ sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.
 - ☐ (sent to the International Bureau only) a total of _____, containing a sequence listing and/or tables related thereto, in electronic form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).

- This report contains indications relating to the following items:

- | | |
|---|---|
| <input checked="" type="checkbox"/> Box No. I | Basis of the report |
| <input type="checkbox"/> Box No. II | Priority |
| <input type="checkbox"/> Box No. III | Non-establishment of opinion with regard to novelty, inventive step and industrial applicability |
| <input type="checkbox"/> Box No. IV | Lack of unity of invention |
| <input checked="" type="checkbox"/> Box No. V | Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement |
| <input type="checkbox"/> Box No. VI | Certain documents cited |
| <input checked="" type="checkbox"/> Box No. VII | Certain defects in the international application |
| <input type="checkbox"/> Box No. VIII | Certain observations on the international application |

Date of submission of the demand 19.01.2005	Date of completion of this report 10.10.2005
Name and mailing address of the IPEA/SE Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Facsimile No. +46 8 667 72 88 Form PCT/IPEA/409 (cover sheet) (April 2005)	Authorized officer Sture Elnäs/MP Telephone No. +46 8 782 25 00

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.

PCT/SE2004/001032

Box No. I Basis of the report

1. With regard to the language, this report is based on:

- ☒ the international application in the language in which it was filed
- ☐ a translation of the international application into _____
which is the language of a translation furnished for the purposes of:
- ☐ international search (Rules 12.3(a) and 23.1(b))
- ☐ publication of the international application (Rule 12.4(a))
- ☐ international preliminary examination (Rules 55.2(a) and/or 55.3(a))

2. With regard to the elements of the international application, this report is based on (replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report):

- ☐ the international application as originally filed/furnished
- ☒ the description:
- pages 1 - 19 _____ as originally filed/furnished
- pages* _____ received by this Authority on _____
- pages* _____ received by this Authority on _____
- ☒ the claims:
- pages _____ as originally filed/furnished
- pages* _____ as amended (together with any statement) under Article 19
- pages* 1 - 5 received by this Authority on 12.09.2005
- pages* _____ received by this Authority on _____
- ☒ the drawings:
- pages 1 - 13 _____ as originally filed/furnished
- pages* _____ received by this Authority on _____
- pages* _____ received by this Authority on _____
- ☐ a sequence listing and/or any related table(s) – see Supplemental Box Relating to Sequence Listing.

3. ☐ The amendments have resulted in the cancellation of:

- ☐ the description, pages _____
- ☐ the claims, Nos. _____
- ☐ the drawings, sheets/figs _____
- ☐ the sequence listing (specify): _____
- ☐ any table(s) related to the sequence listing (specify): _____

4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).

- ☐ the description, pages _____
- ☐ the claims, Nos. _____
- ☐ the drawings, sheets/figs _____
- ☐ the sequence listing (specify): _____
- ☐ any table(s) related to the sequence listing (specify): _____

* If item 4 applies, some or all of those sheets may be marked "superseded."

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.

PCT/SE2004/001032

Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	<u>1-20</u>	YES
	Claims	<u></u>	NO
Inventive step (IS)	Claims	<u>3, 9, 11, 16</u>	YES
	Claims	<u>1-2, 4-8, 10, 12-15, 17-20</u>	NO
Industrial applicability (IA)	Claims	<u>1-20</u>	YES
	Claims	<u></u>	NO

2. Citations and explanations (Rule 70.7)

Reference is made to the following documents:

D1:US6084228

D2:US4804832

D3:EP0625692

D4:US5670774

Additional document, not cited in the International Search Report:

D5:US6379013

D1 discloses a directional solar sensor. The sensor comprises a shading and separating vertically oriented circuit board. A diffuser is positioned between the cover and the sensor surface. According to the document, angular calibration is known.

D2 describes a way of detecting the direction of incoming radiation by means of four detectors separated by shading (and reflecting) elements.

D3 describes a directionally sensitive solar sensor. In an embodiment a filler (silicone or epoxy) is molded onto a matrix of sensor surfaces serving as protection or filter of the sensor. Furthermore, the document describes that using a diffuser is known.

D4 discloses a photo sensor to detect the direction of incidence. The document teaches that angular calibration can be determined by tipping the sensor relative to the direction of incident light.

.../...

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.
Continuation of: BOX V

D5 describes a light sensor in a vehicle equipment control. The document describes a sensor (figure 23) disclosing a housing filled with epoxy (column 19, lines 21-66). Furthermore, in order to direct the light towards the sensor element, a diffusant may be added to the encapsulant (column 37, lines 14-18).

D1 is considered to be closest in describing the invention according to claims 1-20. The invention claimed in claims 1-2, 4-8, 12-15 differs from the sensor described in D1 by stating that at least three sensing elements are used and that they are separated by shading elements. The effect is that the sensor is more directionally sensitive. D1 discloses two sensors separated by one wall, the circuit board. D2 teaches an alternative solution of four sensors separated by four walls. The person skilled in the art, faced with the problem of improving the angular response of the sensor in D1, knows from D2 the solution of using additional sensing elements and shading elements. To divide into at least three sections is also known from the prior art, see for instance US3293440 (cited in the search report).

Since D1 and D2 cover the same technique, it is obvious to a person skilled in the art, faced with the problem of improving the sensor in D1, to further separate the compartments into at least three separate sections.

It is argued that the sensing surfaces in D2 are perpendicular to the shading flanges. However, since the posture of the sensing elements is identical in the invention and in D1, the only difference is the number of compartments and additional separating elements. To further divide the sensor in D1 into more compartments does not involve an inventive step.

Accordingly, the invention claimed in claims 1-2, 4-8, 12-15 does not fulfil the requirement of inventive step.

The invention according to claims 3, 9-11 and 16 differs from D1 by stating a diffusive compound that is a potting positioned between the housing and the sensing element. The effect of the compound is protective and diffusive. However, protecting resins molded into a sensor are known in the art, see for instance each of D3 and D5. The invention claimed in

.../...

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.
Continuation of: BOX V

claim 10 does not fulfil the requirement of inventive step.

A diffusive and filtering means is disclosed in D1. However, the diffusive means is a shell. The diffusing compound described in D5 is added to the encapsulant. A diffusive compound that is a potting, positioned between the housing and the sensing element, is not known from the cited documents. Consequently, the invention claimed in claims 3, 9, 11 and 16 is new and involves an inventive step.

The invention according to claims 17, 18 and 19, 20 differs from D1 by stating a method of calibration and measurement. Calibration of sensors is known from D1, D4 but also from the cited US5264691. For a person skilled in the art of calibration of a directional radiation sensor it is considered obvious to rotate in azimuth and elevation under a light source, save the acquired data and calculate coefficients for all directions. Furthermore, it is considered obvious to use the calibration values for measurements. Consequently, the invention according to claims 17, 18 and 19, 20 does not fulfil the requirement of inventive step.

The invention is industrially applicable.

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.

PCT/SE2004/001032

Box No. VII Certain defects in the international application

The following defects in the form or contents of the international application have been noted:

On page 2 of the claims, part of claim 8 is present.
In claims 9, 10 and 16 reference is made to any one of the preceding claims and "said diffusive compound". However, a diffusive compound is not stated in, for instance, claim 1, 2 or 4.

CLAIMS

1. A photo radiation intensity directional sensor (1) comprising a housing (2) having a transparent or translucent portion (4), and a printed circuit board (7) placed in such way in the housing (2) that one of its edges (37) faces the transparent or translucent portion (4), where at least a first and a second sensing element (5a, 5b) sensitive to radiation are placed at a first side (7') of the printed circuit board (7), where the first and second sensing elements (5a, 5b) are separated by a first flange (8), serving as a shading element, characterized in that at least a third sensing element (5'; 5c) sensitive to radiation is placed at a second side (7'') of the printed circuit board (7), where said sensing elements (5a, 5b, 5'; 5c) are arranged to detect both the direction and the intensity of the radiation source and for producing output signals which are used for estimating the sun radiation heating impact, and where the printed circuit board (7) is arranged in such a way that it functions as a shading element between the areas on its first (7') and second (7'') side where the sensing elements (5a, 5b, 5'; 5c) are mounted.
2. A photo radiation intensity directional sensor according to claim 1, characterized in that a fourth sensing element (5d) is placed at the second side (7'') of the printed circuit board (7), where the third (5c) and fourth (5d) sensing elements are separated by a second flange (9), serving as a shading element.
3. A photo radiation intensity directional sensor according to any one of the claims 1 or 2, characterized in that the housing (2) comprises a chamber (36) containing a diffusive compound (35) that is a potting, which compound (35) is positioned between said housing (2) and said at least one sensing element (5a, 5b, 5'; 5c, 5d).

4. A photo radiation intensity directional sensor according to any one of the preceding claims, characterized in that the shading elements (7, 8, 9) are arranged to prevent exposure of radiation to the sensing elements (5a, 5b, 5'; 5c, 5d) which are separated by the shading elements (7, 8, 9), to a degree depending on the position of the photo radiation intensity directional sensor (1) in relation to a source of photo radiation, said shading elements (7, 8, 9) are thereby arranged for creating differences in output amplitudes from the sensing elements (5a, 5b, 5'; 5c, 5d), which difference in amplitude is used for estimating the position of the source of radiation.
5. A photo radiation intensity directional sensor according to any one of the claims 3 or 4, characterized in that the shading elements (7, 8, 9) divide said chamber (36) into sub compartments, each containing one or several sensing elements (5a, 5b, 5'; 5c, 5d).
6. A photo radiation intensity directional sensor according to claim 5, characterized in that the chamber (36) includes a top region (39) forming part of said sub compartments (12, 13; 25, 26), where said top region (39) is vertically arranged in relation to said shading elements (7, 8, 9) such that said shading elements (7, 8, 9) do not prevent photo radiation from impinging on at least a portion of each sub compartment (12, 13; 25, 26) in said top region (39).
7. A photo radiation intensity directional sensor according to claim 6, characterized in that said top region (39) is positioned vertically above said shading elements (7, 8, 9).
8. A photo radiation intensity directional sensor according to any one of the claims 5 or 6, characterized in that said chamber (36) includes a bottom region (46) forming part of said at least three

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- 5 8. A photo radiation intensity directional sensor according to any one of the claims 5 or 6, characterized in that said chamber (36) includes a bottom region (46) forming part of said at least three sub compartments (12, 13; 25, 26), where said bottom region (46) is vertically arranged below an upper edge (37, 38) of each of said shading elements (7, 8, 9).
- 10 9. A photo radiation intensity directional sensor according to any one of the preceding claims, characterized in that said sensing elements (5a, 5b, 5'; 5c, 5d) are positioned inside said chamber (36) and being exposed to said diffusive compound (35).
- 15 10. A photo radiation intensity directional sensor according to any one of the preceding claims, characterized in that said compound (35) is arranged to preserve said sensing elements (5a, 5b, 5'; 5c, 5d) from oxidizing.
- 20 11. A photo radiation intensity directional sensor according to any one of the claims 2-10, characterized in that the printed circuit board (7) carries further electronic circuits, and is positioned at least partly inside said chamber (36) such that said electronic circuits and sensing elements (5a, 5b, 5'; 5c, 5d) are protected from negative influence on the environment by the diffusive compound (35).
- 25 12. A photo radiation intensity directional sensor according to any of the preceding claims, characterized in that said photo radiation intensity sensor includes a radiation filter transparent to a defined frequency interval, which radiation filter is arranged to block radiation outside said frequency interval from impinging on said
- 30 sensing elements.

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13. A photo radiation intensity directional sensor according to claim 12, characterized in that said radiation filter is constituted by said compound (35).
- 5 14. A photo radiation intensity directional sensor according to claim 12, characterized in that said radiation filter is constituted by a lens element (4).
- 10 15. A photo radiation directional intensity sensor according to any of the preceding claims, characterized in that said sensing elements (5a, 5b, 5'; 5c, 5d) are sensitive to infrared and/or visible light.
- 15 16. A photo radiation directional intensity sensor according to any of the preceding claims, characterized in that said diffusive compound (35) is a liquid or a gel.
- 20 17. A photo radiation directional intensity sensor calibration method for a sensor according to claim 1, comprising the steps:
rotating the sensor (1) 360° in azimuth and from 0° to 90° in elevation under a fixed light source, which rotation takes place in predetermined steps;
measuring all the azimuth steps for each elevation step, where each measurement results in a value from each sensing element (5a, 5b, 5';
25 5c, 5d) that is part of the sensor (1);
saving the acquired data amount in the form of tables and comparing with those of an ideal solar sensor; and
calculating correction coefficients from this comparison.
- 30 18. Calibration method according to claim 17, characterized in that tables containing these correction

coefficients, which tables are converted into graphs, are stored in a digital memory for every individual solar sensor.

19. A photo radiation directional intensity sensor measuring method for a sensor according to claim 1, comprising the steps:
- 5 measuring the output values U_1, U_2, U_3, U_4 from each sensing element (5a, 5b, 5'; 5c, 5d), and saving the measurement values to a digital memory;
- calculating an average value U_{avg} of the signal acquired from the sensing elements (5a, 5b, 5'; 5c, 5d), which average value U_{avg} is proportional to the intensity of the detected radiation;
- 10 calculating differences between output signals of opposite sensing elements (5a, 5b; 5'; 5c, 5d);
- calculating normalized values p and q of the above differences by dividing them with U_{avg} ;
- 15 calculating a first azimuth angle value $A_z = C_1 \arctan(p/q)$, where C_1 is a constant;
- calculating a corrected azimuth angle value, using the calculated first azimuth value A_z and using comparison with correction coefficients;
- calculating a first elevation angle value $E = C_2 \sqrt{p^2 + q^2}$ where C_2 is a constant;
- 20 calculating a corrected elevation angle value, using the calculated first elevation angle value E and using comparison with correction coefficients;
- calculating a first intensity value $I = C_3 U_{avg}$ where C_3 is a constant; and
- 25 calculating a corrected intensity value, using the calculated first intensity value E and using comparison with correction coefficients.
20. Measuring method according to claim 19, characterized in that the correction coefficients are those which are determined according to any one of the claims 17 or 18.